Abstract

In the colder regions of the world, salt is commonly applied to roads and sidewalks in order to prevent icy conditions. While this practice has immediate economic and safety benefits, the continued practice of road salt application has increased concern about the potential for long-term detrimental effects to the environment. Current sample data indicates that these effects include:

- **Aquatic toxicity:** Measured groundwater chloride concentrations of up to 10,900 mg/L; surface water chloride concentrations greater than 400 mg/L.
- **Radium mobilization:** Measured groundwater radium activity up to 19.26 pCi/L. The magnitude of these effects may vary seasonally. Trends from long-term groundwater monitoring data indicate that infiltrating rainwater during non-winter months dilutes the saline winter water.

Study Area

- Six monitoring wells were installed around the porous asphalt parking lot at Storrs Hall on the UConn Campus.
- Sensors are installed in each well; water level and electric conductivity measurements are taken on a ten-minute interval.
- Background (i.e. autumn) [Cl] at this site is over 1000 mg/L, approximately an order of magnitude greater than nearby chloride measurements.
- Pulses of chloride from infiltrating meltwater can exceed 11 g/L, approximately a third the salinity of seawater.

This study aims to assess the implications of continued road salting with respect to hydrogeology and human health.

A note on units:

**Fig. 1:** Interpolated water level surface, showing locations of 6 monitoring wells around the study area.

**Methods and equipment**

**Real-time data resolution**

- Groundwater monitoring probes record water level and electric conductivity on a 10 minute interval.
- Multilevel piezometer installed to understand vertical hydraulic gradient and constituent distribution.

**Low-flow sampling: chloride, metals, radium, radon**

- The low-K clay formation mandates low pumping rates, often <15 mL/min (above).
- Samples are analyzed for 222Rn and 236+238Ra at the CT DPH lab (above right).
- Target metals analyzed at CESE: Na, Ca, Mg, Sr, Ra, Fe, Mn (ICP/MS)
- Samples are analyzed for chloride by ion-specific electrode (above).

**Vertical variation**

<table>
<thead>
<tr>
<th>Screen depth</th>
<th>Shallow</th>
<th>Deep</th>
<th>FBG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl</td>
<td>3417</td>
<td>1947</td>
<td>mg/L</td>
</tr>
<tr>
<td>Mg</td>
<td>64.5</td>
<td>105.5</td>
<td>mg/L</td>
</tr>
<tr>
<td>Ca</td>
<td>289.7</td>
<td>397.9</td>
<td>mg/L</td>
</tr>
<tr>
<td>Ra</td>
<td>1.66</td>
<td>3.44</td>
<td>pCi/L</td>
</tr>
<tr>
<td>Mn</td>
<td>470.0</td>
<td>979.0</td>
<td>pCi/L</td>
</tr>
</tbody>
</table>

- Dissolved metals migrate downward with the water.
- Ra at the water table surface can diffuse out to the soil vapor.

**Conclusions and next steps**

- Rainwater infiltrating through the porous asphalt dilutes high background chloride during non-winter months.
- During winter, road salting increases the ionic strength of this groundwater system, potentially mobilizing radium and other group II cations.
- Variations in radon concentrations can be attributed to many factors, including depth below the water table surface and permeability of the overlying soil.
- Additional sampling is planned at other chloride-contaminated sites in CT in order to (a) verify these hypotheses and (b) understand the magnitude of the impact of salting on radon.

**Current findings and trends**

**I: Long-term monitoring**

- During most of the year, rainwater flushes chloride away from the parking lot. Data span two winters of continuous conductivity monitoring.

**II: Mobilization of radium and salting out of radon**

**Fig. 5 a,b,c:** Spatial distributions of (a) Cl-, (b) Ra and (c) Rn at the site. These data show a positive correlation between radium and chloride, and an inverse relationship between radon and chloride. The latter relationship can be explained by the reduced solubility of Rn in electrolytic solutions (i.e. salting out).

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- Center for Environmental Sciences and Engineering (CESE) sample analysis.

References